REPORT NO. ZW-LB-001

ESTIMATED WEIGHT AND BALANCE OF

(PART ONE)

FOUR ENGINE TRACTOR BOMBARDMENT TYPE AIRPLANE

(AIR CORPS SPECIFICATION 98-208)

MODEL LB38014

(PART TWO)

TWO ENGINE TRACTOR BOMBARDMENT TYPE AIRPLANE

ALTERNATE PROPOSAL

(AIR CORPS SPECIFICATION 98-208

March 11, 1938

BY R. L. Mc Mullen

CHECKED S H Avery

Approved Ray A. Muller

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INTRODUCTION

The estimated structural weight data contained in the Group Weight statement, pages 4 and 5 , is based on our experience in designing airplanes with design gross weights ranging to 50,000#.

Power plant weight data supplied by the Allison Engineering Company, together with detail estimates of installations shown on our preliminary drawings, form the basis for the estimated power plant weights.

The estimated weight of fixed equipment is based on detail weights listed in Type Specification 98-208 of December 20, 1937; and on detail estimates supplemented by actual weights obtained on Consolidated XPB2Y-1 patrol flying boat.

SUMMARY

PART ONE: FOUR ENGINE TRACTOR BOMBARDMENT TYPE AIRPLANE

PART TWO: TWO ENGINE TRACTOR BOMBARDMENT TYPE AIRPLANE ALTERNATE PROPOSAL

Condition	Weight (Lbs.)	Horizontal C. G.			Vertical C.G.		
		Arm Aft L. E.W. (Ft.)	Distance Aft L.E. M.A.C. (Ft.)	% MAC	Below Ref. Line (ft.)	Below M.A.C (Ft.)	% MAC
PART I							
Weight Empty	31965	7.49	3.80	25.9	2.12	.54	3.7
Design Gross Wt.-Wheels Up	56902	6.91	3.22	21.9	2.27	.69	4.7
Design Gross Wt.-Wheels Down	56902	6.88	3.19	21.7	2.66	1.08	7.4
Most Forward C.G.	40102	6.66	2.97	20.2	2.97	1.39	9.5
Most Rearward C.G.	54406	7.34	3.65	24.8	2.05	.47	3.2
Maximum Bomb Load (Alternate)	56904	6.90	3.21	21.8	2.36	.78	5.3
Most Forward C.G.	41976	6.66	2.97	20.2	3.05	1.47	10.0
Most Rearward C.G.	52384	7.35	3.66	24.9	2.15	.57	3.9
.30 cal.in lieu of .50 cal Machine guns (alternate)	56316	6.84	3.15	21.4	2.26	.68	4.6
Most Forward C.G.	39516	6.55	2.86	19.5	2.98	1.40	9.5
Most Rearward C.G.	53820	7.27	3.58	24.4	2.13	.55	3.7
Gun Cameras in lieu of .50 cal. Machine guns (alternate)	56110	6.81	3.12	21.2	2.26	.68	4.6
Most Forward C.G.	39310	6.51	2.82	19.2	2.98	1.40	9.5
Most Rearward C.G.	53614	7.25	3.56	24.2	2.13	.55	3.7
Reconnaissance in Lieu of Mapping Camera Equipt. (Alternate)	56846	6.92	3.23	22.0	2.26	.68	4.6
Most Forward C.G.	40046	6.66	2.97	20.2	2.97	1.39	9.5
Most Rearward C.G.	54350	7.35	3.66	24.9	2.14	.56	3.8
PART II							
Weight Empty	30285	7.48	3.79	25.8	2.11	.53	3.6
Design Gross Weight-Wheels Up	55222	6.89	3.20	21.8	2.26	.68	4.6
Design Gross Wt.-Wheels Down	55222	6.85	3.16	21.5	2.66	1.08	7.4
Most Forward C.G.	38422	6.62	2.93	19.9	2.99	1.41	9.6
Most Rearward C.G.	52726	7.34	3.65	24.8	2.14	.56	3.8

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PART ONE

GROUP WEIGHT STATEMENT

ESTIMATED—~~CALCULATED~~—~~ACTUAL~~

(Cross out those not applicable)

Model LB38014

Contract No. Four Engine Tractor Bombardment Type

Airplane, Government No.

Airplane, Contractor No.

Built by

Engine (model) Allison V-1710-13

Engine Government No.

Date

Changes incorporated in this airplane (Nos. of)

Other modifications incorporated since the first airplane under this contract

Model LB38014

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GROUP WEIGHT STATEMENT

			Landplane	Seaplane
Wing group, including nose cabin			10370	
Wings,				
Ailerons,				
Flaps,				
Struts and wires,				
Tail group,			650	
Stabilizer,				
Elevator,				
Fin,				
Rudder,				
Struts and wires,				
Body group,			6290	
Fuselage, less engine section, incl.4 gun turrets		1340		
Alighting gear—land type, incl.wing reinforce.		4950		
Main landing gear,	3290			
Retracting mechanism,	200			
Auxiliary landing gear,	1360			
Retracting mechanism,	100			
Hull,				
Alighting gear—water type,				
Main floats,				
Main float bracing,				
Auxiliary floats (Disp. lbs.),				
Auxiliary float bracing,				
Retracting mechanism,				
Engine section or nacelle group,				
Power plant group,			10640	
Engine (as installed),		5065		
Engine accessories,		1440		
Power plant controls,		225		
Propeller, (13' dia.-3-blade), Governors, shafts & supports		1945		
Starting system,		225		
Cooling system,		1480		
Radiator and shutters,				
Liquid,				
Piping, etc.,				
Lubricating system,		80		
Tanks,				
Piping, etc.	80			
Fuel system,		180		
Tanks,				
Piping, etc.	180			
TOTALS (To be brought forward)			27950	

GROUP WEIGHT STATEMENT (Cont'd.)

		LANDPLANE	SEAPLANE
Fixed equipment,		4015	
Instruments,	340		
Surface controls,	320		
Furnishings,	1700		
Communicating, (Army),	610		
Electrical,	1045		
Anchor, towing and hoisting gear,			
Arresting hook installation,			
Emergency flotation gear,			
TOTALS (from page 2),		27950	
WEIGHT EMPTY,		31965	

USEFUL LOAD

	Landplane (Spec.)	Seaplane (Spec.)	Landplane (Actual)	Seaplane (Actual)
Crew,	1800			
Fuel, (2800 gals.),	16800			
Oil, (175 gals.),	1312			
Armament,				
Fixed gun and installation,				
Flexible gun and installation, (6)	964			
Bomb and installation,	2669			
Torpedo and installation,				
Pyrotechnics,	108			
Equipment,	1284			
Communicating (Navy),				
Navigating,				
Miscellaneous,				
USEFUL LOAD,	24937			
WEIGHT EMPTY,	31965			
GROSS WEIGHT,	56902			

UNIT WEIGHTS

	nose cabin
Wing group (net area = 1650), lbs. per sq. ft. (wing wt.=8585# not incl.)	5.20
Tail group (net area = 360), lbs. per sq. ft.	1.81
[Submerged displacement main float or hull ( ) / Weight of main float and bracing ( )]	
Weight of cooling system per normal H. P. (H. P. 4000	.37
Weight of lubricating system per gal. oil cap. (200 Gals. of oil)	.400
Weight of fuel system per gal. cap. (2800 Gals.)	.0643

DETAIL WEIGHT & BALANCE - WEIGHT EMPTY

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Landing Gear - Main - Up					
Wheels (4-47" Dia.)	1296.	8.0	10368	1.7	2203
Chassis & Wing Reinf.	1994	9.6	19142	2.3	4586
Retracting Mech.(not incl. elec.motor)	200	11.8	2360	1.5	300
	3490	9.13	31870	2.03	7089
Landing Gear-Main-Down					
Wheels (4-47" dia.)	1296	8.9	11534	9.7	12571
Chassis & Wing Reinf.	1994.	10.3	20538	5.9	11765
Retracting Mechanism	200	11.8	2360	2.2	440
	3490	9.87	34432	7.10	24776
Landing Gear-Nose-Up					
Wheel (1-39" dia.)	170.	- 7.9	- 1343	4.9	833
Chassis & Nose Cabin Reinf.	1190.	-10.7	- 12733	4.6	5474
Retracting Mech.(not incl. electric motor)	100.	-10.7	- 1070	1.8	180
	1460	-10.37	- 15146	4.44	6487
Landing Gear-Nose-Down					
Wheel	170.	-14.5	- 2465	9.5	1615
Chassis & Nose Cabin Reinf.	1190	-13.5	- 16065	7.5	8925
Retracting Mechanism	100	-13.5	- 1350	5.5	550
	1460	-13.62	- 19880	7.6	11090
Engines					
Outboard (2)	2532.5	8.6	21780	1.2	3039
Inboard (2)	2532.5	6.9	17474	2.3	5825
	5065	7.75	39254	1.75	8864
Engine Accessories					
Turbo Supercharger Instal.					
Turbo (4)	520.	13.3	6916	.2	104
Turbo Mounts	28	13.3	372	.2	6
Intercoolers (4)	160.	10.6	1696	.8	128
Intercooler Mounts	16.	10.6	170	.8	13
Air Ducts-Turbo	112.	8.2	918	.3	34
Air Ducts-Intercooler	70.	8.2	574	.3	21
Total Supercharger Instal.	(906.)	(11.75)	(10646)	(.34)	(306)
Miscellaneous Accessories					
Exhaust Stacks	245.	10.8	2646	.9	221
Oil Coolers 8@ 24# (9" dia.)	192.	8.3	1594	.0	0
Oil Temp.Regulators	18.	6.2	112	3.5	63
Vacuum Pumps & Separators	13.	9.9	129	1.5	20
Fuel Pumps	10.	9.9	99	1.5	15
Oil Cooler Air Ducts & Shutters	56	8.2	459	.3	17
Total Miscellaneous Accessories	(534)	(9.44)	(5039)	(.63)	(336)
	1440	10.89	15685	.45	642
Engine Controls					
Throttle	40	3.0	120	5.4	216
Mixture	34	3.0	102	5.4	184
Propellers	32	2.0	64	5.4	173
Supercharger	41	3.3	135	5.4	221
Radiator Shutter	41	3.0	123	5.4	221
Oil Cooler Shutter	37	3.0	111	5.4	200
	225	2.91	655	5.4	1215

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DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Propellers, Governors, Shafts & Supports					
Propellers & Governors (13' dia-3-Blades)	1600	1.3	2080	1.9	3040
Shafts	85	3.4	289	1.9	162
Thrust Bearing & Spline	180	1.5	270	1.9	342
Supports	80	3.2	256	1.9	152
	1945	1.49	2895	1.9	3696
Starting System					
Starters (4)	190	10.6	2014	1.8	342
Starter Cranks (2)	7	10.6	74	1.3	9
Crank Extensions (4)	20	10.6	212	.9	18
Controls	8	10.6	85	1.3	10
	225	10.6	2385	1.68	379
Cooling System					
Inboard Engines					
Radiators (2)	316	7.6	2402	1.8	569
Air Ducts & Shutters	72	7.6	547	2.1	151
Expansion Tanks	8	7.6	61	1.8	14
Piping	40	7.3	292	1.5	60
Coolant (In engines)	124	6.9	856	2.3	285
(In radiators)	106	7.6	806	1.8	191
(In Expansion Tanks)	16	7.6	122	1.8	29
(In Piping)	50	7.3	365	1.5	75
Radiator Supports	8	7.6	61	1.8	14
Total Inboard	(740)		(5512)		(1388)
Outboard Engines					
Radiators (2)	316	8.9	2812	.9	284
Air Ducts and Shutters	72	9.0	648	1.2	86
Expansion Tanks	8	8.9	71	.9	7
Piping	40	8.7	348	1.2	48
Coolant (In Engines)	124	8.6	1066	1.2	149
(In Radiators)	106	8.9	943	.9	95
(In Expansion Tanks)	16	8.9	142	.9	14
(In Piping)	50	8.7	435	1.2	60
Radiator Supports	8	8.9	71	.9	7
Total Outboard	(740)		(6536)		(750)
	1480	8.14	12048	1.44	2138
Oil System					
Oil Lines - Main	57	6.7	382	2.8	160
Drain Valves (4)	9	6.5	59	3.8	34
Auxiliary Power Unit Oil Tank & Supports	9	13.2	119	4.4	40
Auxiliary Power Unit Oil Lines	3	13.2	40	4.4	13
Supercharger Oil Lines	2	9.2	18	1.8	4
	80.	7.73	618	3.14	251
Fuel System					
Hand Fuel Pump	4.	- 4.3	- 17	5.0	20
Valves & Controls	16.	- 4.3	- 69	5.0	80
Piping & Fittings	100.	4.8	480	5.2	520
AEL-1 Units	26	- 4.3	- 112	5.0	130
Refueling Installation	23.	6.0	138	0	0
Dump Valves & Controls	11.	8.6	95	5.2	57
	180.	2.86	515	4.48	807

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DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Instruments					
Pilots' Panel					
2 Airspeed Indicators Type D-4	2.0				
2 Bk. & Turn Indicators Type A-5	3.0				
2 Rate of Climb Indicators Type A-6	3.5				
2 Altimeters Type C-10	2.4				
1 Clock Type A-7	.75				
1 Turn Indicator Type A-3	4.25				
1 Turn Indicator Type B-3 1 Controller for B-3 turn Indicator 1 Flexible Shaft for B-3 Turn Indicator	10.75				
2 Flight Indicators Type C-5	9.5				
2 Suction Gages Type F-2	1.1				
1 Air Thermometer Type C-6	2.0				
1 Compass Type D-12	7.75				
1 Landing Gear Indicator	1.0				
1 Nose Land.Gear Indicator	1.0				
1 Flap Position Indicator	1.0				
2 Tachometer Indicators (Dual-Autosyn)	4.0				
2 Manifold Pressure Indicators (Dual-Autosyn)	4.0				
2 Oil Temp. Indicators (Dual-Autosyn)	4.0				
2 Oil Pressure Indicators (Dual-Autosyn)	4.0				
2 Fuel Pressure Indicators (Dual-Autosyn)	4.0				
2 Fuel Warning Signals	.8				
1 Radio Compass Indicator	.8				
Gyro Director Indicator	11.0				
Pilot Director Mountings	.1				
Artificial Horizon	6.1				
Total Pilots' Installation	88.8	-14.2	- 1261	2.1	186
Flight Engineer's Panel					
1 Altimeter	1.2				
1 Suction Gage Type F-2	.5				
1 Air Thermometer Type C-6	2.0				
2 Tachometer Indicators (Dual-Autosyn)	4.0				
2 Manifold Pressure Indicators (Dual-Autosyn)	4.0				
2 Oil Temperature Indicators (Dual-Autosyn)	4.0				
2 Oil Pressure Indicators (Dual-Autosyn)	4.0				

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DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Flight Engineer's Panel (Cont'd.)					
2 Fuel Pressure Indicators (Dual-Autosyn)	4.0				
4 Thermocouple Indicators	7.5				
4 4-Point Thermocouple Switches	1.9				
4 Thermometers (Liquid Cooled Engines)	5.2				
1 Fuel Mixture Indicator (Quad. type)	12.				
4 Thermometer, Carb. Mixture Type F-2	4.5				
2 Fuel Flow Indicators (Dual-Autosyn)	4.0				
2 Fuel Warning Signals	.8				
Oil Quantity Gage Installation	11.3				
Total Flight Engineer's Instal.	(70.9)	- 4.1	- 291	2.4	170
Navigator's Panel					
1 Airspeed Indicator Type D-4	1.0				
1 Altimeter, Type C-10	1.2				
1 Clock, Type A-7	.75				
1 Air Thermometer	2.0				
Radio Compass Indicator	.8				
Total Navigator's Panel	(5.75)	- 8.0	- 46	2.2	13
Bomber's Panel					
1 Airspeed Indicator, Type D-4	1.0				
1 Altimeter, Type C-10	1.2				
1 Clock Type A-7	.75				
1 Compass Type B-17	1.5				
1 Air Thermometer, Type C-6	2.0				
Total Bomber's Panel	(6.45)	-17.6	- 114	2.8	18
Miscellaneous Instruments, Tubing, etc.					
2 Airspeed Tubes, Type C-3	2.0	4.0	8	2.5	5
2 Clocks	1.5	- 6.4	- 10	3.8	6
1 Compass Type B-17	1.5	- 8.4	- 13	3.6	5
1 Drift Meter, Type B-13	20.0	- 7.9	- 158	3.3	66
1 Computer, Type A-4	2.5	- 7.9	- 20	3.3	8
1 Navigation Case, Type A-4	4.0	- 7.9	- 32	3.3	13
1 Bomb Door Indicator	1.0	-14.2	- 14	2.0	2
Fuel Quantity Indicator	12.8	-14.2	- 182	2.0	26
4 Thermocouple Leads	15.4	3.9	60	3.6	55
4 Manifold Pressure Transmitter	6.8	7.8	53	1.7	12
4 Fuel Flow Transmitter	16.0	7.8	125	1.7	27
4 Fuel Pressure Transmitters	6.6	7.8	51	1.7	11
4 Oil Pressure Transmitters	5.6	7.8	44	1.7	9
4 Oil Temperature Transmitters	7.0	7.8	55	1.7	12
Landing Gear Position Transmitters	2.0	10.0	20	6.0	10
Nose Gear Position Transmitter	2.0	12.0	24	5.0	10
Flap Position Transmitter	2.0	13.8	28	3.8	8

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DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Misc. Instruments, Tubing, etc. (Cont'd.)					
Bomb Door Position Transmitter	2.0	8.0	16	5.5	11
Correction Card Holder Transmitter	1.0	- 3.0	- 3	2.6	3
Wire-Transmitters to Indicators	10.0	1.0	10	3.6	36
Vacuum Lines	8.0	- 1.0	- 8	4.2	34
Emergency Vacuum Pump	4.4	-10.5	- 46	2.8	12
Instrument Lines	9.5	- 3.0	- 29	4.0	38
Syncroscope	1.0	-14.0	- 14	2.0	2
Bolts, Nuts, Rivets, Tape, etc.	16.0	1.0	16	4.0	64
Total Miscellaneous	(160.6)		(- 19)		(485)
Auxiliary Power Units					
Oil Pressure	7				
Cylinder Temp. Indicator & Switch	1.8				
Oil Temp. Indicator	1.6				
Tubing, Thermo Leads, Standard Parts	3.4				
Total Aux. Power Unit	(7.5)	11.5	86	1.5	11
	340.0	- 4.84	- 1645	2.60	883
Surface Controls					
Supports, Bellcranks, Rods, etc. (S.B.A.E.)	10.	-12.5	- 125	5.8	58
Control Columns	35.	-13.5	- 473	4.0	140
Rudder Pedals	25.	-14.8	- 370	4.0	100
Aileron Tab Control	10.	5.5	55	5.5	55
Elevator Tab Controls	15.	18.4	276	5.5	83
Rudder Tab Control	15.	18.4	276	5.5	83
Aileron Controls	60.	5.5	330	5.5	330
Elevator Controls	50.	18.4	920	5.5	275
Rudder Controls	40.	18.4	736	5.5	220
Flap Controls	60.	11.0	660	3.0	180
	320.	7.14	2285	4.76	1524
Furnishings					
Pilot's Seats & Tracks	48.	-11.8	- 566	4.0	192
Engineer's Seat & Base	11.	- 4.1	- 45	4.8	53
Radio Operator's Seat & Base	9.	- 4.1	- 37	4.8	43
Navigator's Seat & Base	9.	- 7.9	- 71	4.0	36
Commander's Seat, Cushion & Raising Mechanism	26.	- 7.0	- 182	4.5	117
Bomber's Seat	7.	-14.8	- 104	4.7	33
Front Gunner's Seats (2)	7.	2.4	17	5.0	35
Side Gunner's Seats (2)	7.	21.8	153	4.6	32
Photographer's Seat & Stowage	5.	6.3	32	5.1	26
Seat Cushions					
Pilot's	17.	-11.8	- 201	3.8	65
Engineer's	5.	- 4.1	- 21	4.6	23
Radio Operator's	5.	- 4.1	- 21	4.6	23
Navigator's	5.	- 7.9	- 40	3.6	18

BY _____ CHECKED _____

DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Furnishings (Cont'd.)					
Tables & Supports					
Engineer's	27.	- 4.4	- 119	3.8	103
Radio Operator's	15	- 4.4	- 66	4.0	60
Navigator's	27.	- 8.0	- 216	2.7	73
Commander's	18.	- 8.8	- 158	2.9	52
Bomber's	1.5	-16.	- 24	5.	8
Instrument Panels					
Pilot's	7.	-14.2	- 99	2.1	15
Navigator's	2.	- 8.0	- 16	2.2	4
Bomber's	2.	-17.6	- 35	2.8	6
Aux.Power Unit	.5	11.5	6	1.5	1
Engineer's	15.	- 4.1	- 61	2.4	36
Ammunition Racks					
Front Guns (2)	8.	1.8	14	2.5	20
Side Guns (2)	8.	24.0	192	2.2	18
Top Turret Gun (1)	4.	27.2	109	2.2	9
Bottom Turret Gun (1)	4.	15.7	63	3.8	15
Gun Stowages					
Front Guns (2)	4.	1.0	4	3.2	13
Side Guns (2)	4.	20.8	83	2.8	11
Top Turret Gun (1)	2.	27.5	55	1.5	3
Bottom Turret Gun (1)	2.	16.0	32.	3.6	7
Gun Mounts					
Front Guns (2)	60.	- 1.5	- 90	3.3	198
Side Guns (2)	20.	21.8	436	2.6	52
Top Turret Gun (1)	10.	27.5	275	1.5	15
Bottom Turret Gun (1)	10.	16.0	160	3.6	36
Lockers					
Refrigerator,Food,Utensils	60.	8.0	480	1.8	108
Clothes Locker	15.	5.0	75	3.2	48
Spare Parts & Tools	15.	5.0	75	3.2	48
Tool Container	2.	5.0	10	3.2	6
Fire Extinguishers					
Hand Liquid-Type A-2 (2)	14.	1.0	14	2.0	28
Portable CO_2 (2)	24.	12.4	298	4.4	106
Engine Pressure-Type A-12 (2)	50.	- 5.	- 25	3.5	175
Flare Release Mechanism	30	1.0	30	5.2	156
Flare Stowage	5.	5.0	25	3.2	16
Bombsight Mount	16	16.3	261	4.3	69
Safety Belts					
Gunner's 8 @ 2.8	22.4	9.0	202	3.5	78
Pilot's Type 6 @ 2.7	16.2	- 8.0	- 130	4.0	65
Signal Pistol & Amm.Holder	3.	9.0	27	3.0	9
Radio Supports	18.	- 4.1	- 74	2.7	49
Pilot's Curtains	3.	-15.0	- 45	1.5	5
Photographic W.E.Spec.					
Camera Mount Adapting Member	3.	4.1	12	5.0	15
Vert.View Finder Ring Instal.	.6	5.4	3	5.0	3

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DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Furnishings (Cont'd.)					
Aux.Power Unit					
Firewalls,Drip Pans,etc.	9.	13.2	119	4.4	40
Supports	19.	13.2	251	4.4	84
Pilot's Blind Flying Curtain & Stowage	15.	-13.0	- 195	3.0	45
Water Containers	11.	9.2	101	1.0	11
Toilet,Paper,Bags,Stowage	12.	11.4	137	5.3	64
Relief Tubes	1.5	-15.0	- 23	4.0	6
Life Rafts (2)	112.	8.5	952	4.3	482
First Aid Kit	4.	12.0	48	1.8	7
Wash Basin & Water Container	4.	9.6	38	2.1	8
Entrance Ladder	15.	- 4.1	- 62	5.0	75
Bomb Racks Incl.Controls	260.	4.2	1092	3.8	988
Surface Control Lock	4.	-12.0	- 48	4.3	17
Map Case	.5	-11.0	- 6	3.5	2
De-Icing Equipt.& Provision	450.	12.5	5625	0.0	0
Oxygen Supports (24 Bottles)	5.	5.0	25	3.4	17
Heating & Ventilating	50.	- 3.0	- 150	5.8	290
Allowance for Misc.Stowages & Contingencies	18.5	1.0	19	3.2	59
	1700.	5.07	8620	2.72	4630
Electrical System					
Aux.Power Units	400.	13.2	5280	4.4	1760
Batteries (2)	140.	- 4.0	- 560	3.3	462
Electric Motors	150	8.2	1230	3.2	480
Wiring,Conduit,Lights,etc.	355.	2.5	888	2.0	710
	1045.	6.54	6838	3.27	3412

BY _____

CHECKED _____

DETAIL WEIGHT & BALANCE - USEFUL LOAD

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Crew & Parachutes					
Pilot	180.	-12.0	- 2160	3.1	558
Co-pilot	180	-12.0	- 2160	3.1	558
Bomber	180	-15.4	- 2772	4.3	774
Front Gun Positions (2)	360	+ 1.9	684	4.4	1584
Radio Operator	180	- 4.1	- 738	4.1	738
Navigator	180	- 7.9	- 1422	4.1	738
Engineer	180	- 4.1	- 738	4.1	738
Commander	180	- 7.0	- 1260	4.1	738
Parachutes 9 @ 20#	180	- 6.5	- 1170	3.8	684
	1800	- 6.52	- 11736	3.95	7110
Flexible Guns					
2-.50 cal.Front Guns & 400 Rds. Ammunition	321.4	- 1.5	- 482	3.3	1061
2-.50 cal.Fuselage Side Guns & 400 Rds.Ammunition	321.4	21.8	7007	2.6	836
2-.50 cal.Top & Bottom Turret Guns & 400 Rds.Ammunition	321.4	21.8	7007	2.6	836
	964.	14.04	13532	2.84	2733
Bomb Installation					
4-600# Bombs	2496	6.5	16224	4.5	11232
4-B-7 Shackles	10.8	6.7	72	3.0	32
1-Bombsight Instal.(S.B.A.E.)	161	-14.0	- 2254	5.0	805
Firing Key & Pilot Director	1.	-14.5	- 15	4.3	4
	2669.	5.26	14027	4.52	12073
Pyrotechnics					
6 Flares					
2 In release racks	32.5	2.7	88	5.0	163
4 In stowage racks	65.	4.9	319	3.5	228
Signal Pistols & Ammunition	10.	9.0	90	3.0	30
	108.	4.60	497	3.90	421
Equipment					
Navigation	40.	- 7.9	- 316	3.8	152
Photographic	146.	4.4	642	5.5	803
Oxygen	660	4.6	3036	3.8	2508
Aux.Power Unit Fuel-50 gals.	300	7.4	2220	1.9	570
Aux.Power Unit Oil-4 gals.	30	13.2	396	4.4	132
Food (14 hrs.-4#/man)	36	10.	360	4.6	166
Water (14 hrs.-3#/man)	27	9.2	248	1.0	27
Hoisting Sling	20	8.5	170	3.4	68
Tools	25	4.9	123.	3.4	85
	1284	5.36	6879	3.51	4511

BY _____

CHECKED _____

DESIGN GROSS WEIGHT - C.G. TRAVEL

	Horizontal			Vertical	
	Weight	Arm	Moment	Arm	Moment
Design Gross Weight C.G. - Wheels Down					
Design Gross Weight-Wheels Up	56902	6.91	393380	2.27	128926
Less: Landing Gear-Main-Up	- 3490	9.13	- 31870	2.03	- 7089
n Landing Gear-Nose-Up	- 1460	-10.37	+ 15146	4.44	- 6487
Plus: Landing Gear-Main-Down	+ 3490	9.87	34432	7.10	24776
Landing Gear-Nose-Down	+ 1460	-13.62	- 19880	7.6	11090
Design Gross Weight-Wheels Down	56902	6.88	391208	2.66	151216

$$\text{Horizontal C.G.} = \frac{6.88 - 3.69}{14.7} = \frac{3.19}{14.7} = 21.7\% \text{ MAC}$$

Vertical C.G. = 2.66 ft. below reference line

Most Forward Flight C.G.					
Design Gross Weight-Wheels Down	56902	6.88	391208		151216
Less: Fuel (2800 gals.)	-16800	7.4	-124320	1.9	- 31920
	40102	6.66	266888	2.97	119296

$$\text{Horizontal C.G.} = \frac{6.66 - 3.69}{14.7} = \frac{2.97}{14.7} = 20.2\% \text{ M.A.C.}$$

Vertical C.G. = 2.97 ft. below reference line

Most Rearward Flight C.G.					
Design Gross Weight-Wheels Up	56902	6.91	393380	2.27	128926
Less: Forward Crew	- 1800	- 6.52	+ 11736	3.95	7110
Plus: Most Aft Crew					
Pilot	180	-12.0		3.1	
Commander	180	- 7.0		4.1	
Bomber	180	-15.4		4.3	
2 Front Gunners	360	1.9		4.4	
2 Rear Side Gunners	360	21.8		2.6	
1 Top Turret Gunner	180	27.2		2.2	
1 Bottom Turret Gunner	180	15.7		3.8	
Parachutes = 9 @ 20#	180	- 6.5		3.8	
Total Most Aft Crew	1800	5.94	10692	3.53	5954
Less: Bombs (4-600#)	- 2496	6.5	- 16224	4.5	11232
	54406	7.34	399584	2.05	116538

$$\text{Horizontal C.G.} = \frac{7.34 - 3.69}{14.7} = \frac{3.65}{14.7} = 24.8\% \text{ M.A.C.}$$

Vertical C.G. = 2.05 ft. below reference line

BY _____

CHECKED _____

ALTERNATE LOADINGS AND C.G. TRAVEL

	Horizontal			Vertical	
	Weight	Arm	Moment	Arm	Moment
Maximum Bomb Load					
Design Gross Weight-wheels up	56902	6.91	393380	2.27	128926
Less: Normal Design Bomb Load (4-600# Bombs)	- 2496	6.5	- 16224	4.5	- 11232
Plus: 4-1100# Bombs M-33	4520	6.6	29832	4.5	20340
Less: 312 Gals.Fuel @6#/gal.	- 1872	7.4	- 13853	1.9	- 3557
20 gals.oil @ 7.5#/gal.	- 150	5.0	- 750	1.8	- 270
	56904	6.90	392385	2.36	134207

$$\text{Horizontal C.G.} = \frac{6.90 - 3.69}{14.7} = \frac{3.21}{14.7} = 21.8\% \text{ M.A.C.}$$

Vertical C.G. = 2.36 ft. below ref.line

Most Forward Flight C.G.-Maximum Bomb Load					
Design Gross Weight-Wheels Down	56902	6.88	391208		151216
Less: Normal Bomb Load	- 2496	6.5	- 16224	4.5	- 11232
Plus: 4-1100# Bombs	+ 4520	6.6	29832	4.5	20340
Less: 20 gals.Oil @ 7.5#/gal.	- 150	5.0	- 750	1.8	- 270
2800 gals.fuel @ 6#/gal.	- 16800	7.4	-124320	1.9	- 31920
	41,976	6.66	279746	3.05	128134

$$\text{Horizontal C.G.} = \frac{6.66 - 3.69}{14.7} = \frac{2.97}{14.7} = 20.2\% \text{ M.A.C.}$$

Vertical C.G. = 3.05 ft. below reference line

Most Rearward Flight C.G. - Maximum Bomb Load					
Maximum Bomb Load-Gross Weight	56904	6.90	392385	2.36	134207
Less: Forward Crew	- 1800	- 6.52	+ 11736	3.95	- 7110
Plus: Aft Crew	1800	5.94	10692	3.53	5954
Less: Bombs (4-1100#)	- 4520	6.6	- 29832	4.5	- 20340
	52384	7.35	384981	2.15	112711

$$\text{Horizontal C.G.} = \frac{7.35 - 3.69}{14.7} = \frac{3.66}{14.7} = 24.9\% \text{ M.A.C.}$$

Vertical C.G. = 2.15 ft. below reference line

.30 cal.in Lieu of .50 cal.Machine Guns					
Design Gross Weight-Wheels up	56902	6.91	393380	2.27	128926
Less: .50 cal.guns & amm.	- 964	14.04	- 13532	2.84	- 2733
Plus: .30 cal. guns & Amm.					
2 Nose guns & 1000 rds.amm.	126				
2 Rear side guns & 1000 rds.amm.	126				
2 Turret guns & 1000 rds. amm.	126				
Total .30 cal. & amm.	378	14.04	5307	2.84	1074
	56316	6.84	385155	2.26	127267

$$\text{Horizontal C.G.} = \frac{6.84 - 3.69}{14.7} = \frac{3.15}{14.7} = 21.4\% \text{ M.A.C.}$$

Vertical C.G. = 2.26 ft. below reference line

BY _____

CHECKED _____

ALTERNATE LOADINGS & C.G. TRAVEL (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Most Forward Flight C.G. - .30 cal. in lieu of .50 cal. guns					
Design Gross Weight-Wheels Down	56902	6.88	391208	2.66	151216
Less: .50 cal. guns & amm.	- 964	14.04	- 13532	2.84	- 2733
Plus: .30 cal. guns & amm.	378	14.04	5307	2.84	+ 1074
Less: Fuel (2800 gals.)	-16800	7.4	-124320	1.9	- 31920
	39516	6.55	258663	2.98	117637

$$\text{Horizontal C.G.} = \frac{6.55 - 3.69}{14.7} = \frac{2.86}{14.7} = 19.5\% \text{ M.A.C.}$$

Vertical C.G. = 2.98 ft. below reference line

Most Rearward Flight C.G. - .30 cal. in Lieu of .50 cal. Guns					
.30 cal. Gun Gross Weight	56316	6.84	385155	2.26	127267
Less: Forward Crew	- 1800		+ 11736		- 7110
Plus: Aft Crew	1800		10692		5954
Less: Bombs (4-600#)	- 2496	6.5	- 16224	4.5	- 11232
	53820	7.27	391359	2.13	114879

$$\text{Horizontal C.G.} = \frac{7.27 - 3.69}{14.7} = \frac{3.58}{14.7} = 24.4\% \text{ M.A.C.}$$

Vertical C.G. = 2.13 ft. below reference line

Gun Cameras in Lieu of .50 cal. Machine Guns					
Design Gross Weight-Wheel up	56902	6.91	393380	2.27	128926
Less: .50 cal. Guns & Amm.	- 964	14.04	- 13532	2.84	- 2733
Plus: Gun Cameras					
2-Nose Guns	57.3				
2-Rear Side Guns	57.3				
2-Turret Guns	57.3				
Total Gun Cameras	172.	14.04	2415	2.84	488
	56110	6.81	382263	2.26	126681

$$\text{Horizontal C.G.} = \frac{6.81 - 3.69}{14.7} = \frac{3.12}{14.7} = 21.2\% \text{ M.A.C.}$$

Vertical C.G. = 2.26 ft. below reference line

Most Forward Flight C.G. - Gun Cameras in Lieu of .50 cal. Gun					
Design Gross Weight-Wheels Down	56902	6.88	391208	2.66	151216
Less: .50 cal. guns & amm.	- 964		- 13532		- 2733
Plus: Gun Cameras	172		2415		488
Less: Fuel (2800 gals.)	-16800	7.4	-124320	1.9	- 31900
	39310	6.51	255771	2.98	117071

$$\text{Horizontal C.G.} = \frac{6.51 - 3.69}{14.7} = \frac{2.82}{14.7} = 19.2\% \text{ M.A.C.}$$

Vertical C.G. = 2.98 ft. below reference line

BY _____

CHECKED _____

ALTERNATE LOADINGS & C.G. TRAVEL (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Most Rearward Flight C.G.-Gun Cameras in Lieu of .50 cal Guns					
Gun Camera Gross Weight	56110	6.81	382263		126681
Less: Forward Crew	- 1800		+ 11736		- 7110
Plus: Aft Crew	1800		10692		5954
Less: Bombs (4-600#)	- 2496	6.5	- 16224	4.5	-11232
	53614	7.25	388467	2.13	114293

$$\text{Horizontal C.G.} = \frac{7.25 - 3.69}{14.7} = \frac{3.56}{14.7} = 24.2\% \text{ M.A.C.}$$

Vertical C.G. = 2.13 ft. below reference line

Rapid Reconnaissance in Lieu of Tactical Mapping Mission Camera Equipt.					
Design Gross Weight-Wheels Up	56902	6.91	393380	2.27	128926
Less: Tactical Mapping Mission Camera Equipment	- 146	4.4	- 642	5.5	- 803
Plus: Rapid Reconnaissance Mapping Mission Camera Equipt.	90	4.4	396	5.5	495
	56846	6.92	393134	2.26	128618

$$\text{Horizontal C.G.} = \frac{6.92 - 3.69}{14.7} = \frac{3.23}{14.7} = 22.0\% \text{ M.A.C.}$$

Vertical C.G. = 2.26 ft. below reference line

Most Forward Flight C.G.-Rapid Reconnaissance in Lieu of Tactical Mapping Mission Camera Equipment					
Design Gross Weight-Wheels Down	56902	6.88	391208	2.66	151216
Less: Tactical mapping mission camera equipment	- 146		- 642		- 803
Plus: Rapid Reconnaissance Camera Equipment	90		396		495
Less: Fuel (2800 gals.)	-16800	7.4	-124320	1.9	- 31900
	40046	6.66	266642	2.97	119008

$$\text{Horizontal C.G.} = \frac{6.66 - 3.69}{14.7} = \frac{2.97}{14.7} = 20.2\% \text{ M.A.C.}$$

Vertical C.G. = 2.97 ft. below reference line

Most Rearward Flight C.G.-Rapid Reconnaissance in Lieu of Tactical Mapping Mission Camera Equipment					
Reconnaissance Camera Gross Wt.	56846	6.92	393134		128618
Less: Forward Crew	- 1800		11736		- 7110
Plus: Aft Crew	1800		10692		5954
Less: Bombs (4-600#)	- 2496	6.5	- 16224	4.5	- 11232
	54350	7.35	399338	2.14	116230

$$\text{Horizontal C.G.} = \frac{7.35 - 3.69}{14.7} = \frac{3.66}{14.7} = 24.9\% \text{ M.A.C.}$$

Vertical C.G. = 2.14 ft. below reference line

BY _____

CHECKED _____

PART TWO

TWO ENGINE ALTERNATE PROPOSAL (AIR CORPS SPEC. 98-208)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Weight Empty Summary					
1. Wing Group Incl.Nose Cabin	10120	6.8	68816	2.1	21252
2. Tail Group	650	52.5	34125	- .5	- 325
3. Fuselage Incl.4 Gun Turrets	1340	22.6	30284	2.0	2680
4. *Landing Gear-Main-Up	3490	9.17	31992	2.04	7135
5. *Landing Gear-Nose-Up	1460	-10.37	- 15146	4.44	6487
6. Engines (2-2000 H.P.Allison)	4480	6.9	30912	1.5	6720
7. *Engine Accessories	1405	12.56	17643	1.58	2226
8. *Engine Controls	140	2.97	416	5.39	755
9. *Propellers,Governors,Shafts and Supports	1590	.41	646	1.5	2385
10. *Starting System	160	10.2	1632	1.5	240
11. *Cooling System	1405	7.67	10774	1.29	1817
12. *Oil System	60	7.47	448	2.85	171
13. *Fuel System	130	3.45	448	4.24	551
14. *Instruments	270.	- 5.84	- 1577	2.66	719
15. Surface Controls (See 4 engine tractor)	320	7.14	2285	4.76	1524
16. *Furnishings	1625	5.31	8623	2.75	4467
17. *Electrical System	1030	6.60	6800	3.28	3382
18. Radio	610	- 4.1	- 2501	2.7	1647
Weight Empty	30285	7.48	226620	2.11	63833

Horizontal C.G.

Reference Line = L.E.W. (Root Section)

M.A.C. = 14.7'

L.E. M.A.C. aft reference line = 3.69 ft.

$$C.G. = \frac{7.48 - 3.69}{14.7} = \frac{3.79}{14.7} = 25.8\% \text{ M.A.C.}$$

Vertical C.G.

Below reference line = 2.11 ft.

M.A.C. below reference line = 1.58 ft.

C.G. below M.A.C. = .53 ft.

C.G. = 3.6% M.A.C.

*For detail breakdown, see pages 21-23.

DETAIL WEIGHT & BALANCE - WEIGHT EMPTY

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Landing Gear-Main-Up					
Wheels	1220	8.0	9760	1.7	2074
Chassis & Wing Reinforcements	2070	9.6	19872	2.3	4761
Retracting mechanism	200	11.8	2360	1.5	300
	3490	9.17	31992	2.04	7135
Landing Gear-Main-Down					
Wheels	1220	8.9	10858	9.7	11834
Chassis & Wing Reinforcements	2070	10.3	21321	5.9	12213
Retracting Mechanism	200	11.8	2360	2.2	440
	3490	9.90	34539	7.02	24487
Landing Gear-Nose-Up					
Wheel	170	- 7.9	- 1343	4.9	833
Chassis & Nose Cabin Reinforcements	1190	-10.7	- 12733	4.6	5474
Retracting Mechanism	100	-10.7	- 1070	1.8	180
	1460	-10.37	- 15146	4.44	6487
Landing Gear-Nose-Down					
Wheel	170	-14.5	- 2465	9.5	1615
Chassis & Nose Cabin Reinforcement	1190	-13.5	- 16065	7.5	8925
Retracting Mechanism	100	-13.5	- 1350	5.5	550
	1460	-13.62	- 19880	7.6	11090
Engine Accessories					
Turbo Supercharger Installation					
Turbo (4)	520	15.4	8008	1.3	676
Turbo Mounts	28	15.4	431	1.3	36
Intercoolers (4)	160	13.3	2128	1.2	192
Intercooler Mounts	16	13.3	213	1.2	19
Air Ducts-Turbo	112	9.5	1064	1.5	168
Air Ducts-Intercooler	92	9.5	874	1.5	138
Total Supercharger Instal.	(928)	(13.70)	(12718)	(1.32)	(1229)
Miscellaneous Accessories					
Exhaust Stacks	245	12.4	3038	2.0	490
Oil Coolers	160	7.8	1248	2.2	352
Oil Temperature Regulators	9	6.2	56	3.5	32
Vacuum Pump & Separators	13	9.8	127	1.5	19
Fuel Pumps	8	9.8	78	1.5	12
Oil Cooler Air Ducts & Shutters	42	9.0	378	2.2	92
Total Misc.Accessories	(477)	(10.32)	(4925)	(2.09)	(997)
	1405	12.56	17643	1.58	2226
Engine Controls					
Throttle	19	3.0	57	5.4	103
Mixture	16	3.0	48	5.4	86
Propellers	15	2.0	30	5.4	81
Supercharger	36	3.3	119	5.4	194
Radiator Shutters	36	3.0	108	5.4	194
Oil Cooler Shutters	18	3.0	54	5.4	97
	140	2.97	416	5.39	755
Propellers,governors,shafts & Suppts					
Propellers & Governors (16' dia.-3-Blade)	1300	.2	260	1.5	1950
Shafts (2)	74	2.3	170	1.5	111
Thrust Bearings & Spline Supports	156	.5	78	1.5	234
	60	2.3	138	1.5	90
	1590	.41	646	1.5	2385

BY CHECKED

DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Starting System					
Starters (2)	137				
Starter Cranks (2)	7				
Crank Extensions (2)	10				
Controls	6				
	160	10.2	1632	1.5	240
Cooling System					
Radiators (4)	512	7.8	3994	1.2	614
Air Ducts & Shutters	145	8.6	1247	1.3	189
Expansion Tanks	12	7.8	94	1.3	16
Piping	66	7.4	488	1.4	92
Coolant (In Engines)	238	6.9	1642	1.5	357
(In Radiators)	198	7.8	1544	1.2	238
(In Expansion Tanks)	66	7.8	515	1.2	79
(In Piping)	152	7.4	1125	1.4	213
Radiator Supports	16	7.8	125	1.2	19
	1405	7.67	10774	1.29	1817
Oil System					
Oil Lines-Main	41	6.0	246	2.3	94
Drain Valves	6	5.5	33	4.2	25
Aux.Power Unit Oil Tank & Suppts.	9	13.2	119	4.4	40
Aux.Power Unit Oil Lines	2	13.2	26	4.4	9
Supercharger Oil Lines	2	12.0	24	1.7	3
	60	7.47	448	2.85	171
Fuel System					
Hand Fuel Pump	4	- 4.3	- 17	5.0	20
Valves & Controls	8	- 4.3	- 34	5.0	40
Piping & Fittings	69	4.8	331	5.2	359
AEL-1 Units	15	- 4.3	- 65	5.0	75
Refueling Installation	23	6.0	138	0	0
Dump Valves & Controls	11	8.6	95	5.2	57
	130	3.45	448	4.24	551
Instruments					
Pilots' Panel (4 engine Tractor Weight less wt. difference of instruments required for 2 engines instead of 4)	78.0	-14.2	- 1108	2.1	164
Flight Engineer's Panel (4 Engine Tractor Weight less wt. difference of instruments required for 2 engines instead of 4)	43.7	- 4.1	- 179	2.4	105
Navigator's Panel (Same wt.as 4 engine tractor)	5.75	-8.0	- 46	2.2	13
Bomber's Panel (Same wt.as 4 engine tractor)	6.45	-17.6	- 114	2.8	18
Miscellaneous Instruments,Tubing,Etc. (Same wt.as 4 engine tractor less the following items):	160.6		- 19		485

BY _____

CHECKED _____

DETAIL WEIGHT & BALANCE - WEIGHT EMPTY (Cont'd.)

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Instruments (Cont'd.)					
Misc. Instruments, Tubing, etc. (Cont'd.)					
2 Thermocouple leads	- 7.7	3.9	- 30	3.6	- 28
2 Manifold Pressure Transmitters	- 3.4	7.8	- 27	1.7	- 6
2 Fuel Flow Transmitters	- 8.0	7.8	- 62	1.7	- 14
2 Fuel Pressure Transmitters	- 3.3	7.8	- 26	1.7	- 6
2 Oil Pressure Transmitters	- 2.8	7.8	- 22	1.7	- 5
2 Oil Temperature Transmitters	- 3.5	7.8	- 27	1.7	- 6
Wire-Transmitters to Indicators	- 3.3	1.0	- 3	3.6	- 12
Total Miscellaneous	(128.6)	(-1.68)	(- 216)	(3.17)	(408
Auxiliary Power Units (Same wt. as 4 engine tractor)	7.5	11.5	86	1.5	11
	270.	- 5.84	- 1577	2.66	719
Furnishings					
(Same wt. as 4 engine tractor less the following items):	1700		8620		4630
1 Engine Pressure Fire Extinguisher	-25.	- .5	13	3.5	- 88
De-Icing Installation for 2 of the 4 engine tractor propellers	- 50.	.2	- 10	1.5	- 75
	1625.	5.31	8623	2.75	4467
Electrical System					
Aux. Power Units	400	13.2	5280	4.4	1760
Batteries (2)	140	- 4.0	- 560	3.3	462
Electric Motors	150	8.2	1230	3.2	480
Wiring & Conduit, Lights, etc.	340	2.5	850	2.0	680
	1030	6.60	6800	3.28	3382

BY _____

CHECKED _____

DESIGN GROSS WEIGHT & C.G. TRAVEL

	Weight	Horizontal Arm	Horizontal Moment	Vertical Arm	Vertical Moment
Design Gross Weight-Wheels Up					
*Design Useful Load	24937		154079		61130
Weight Empty	30285		226620		63833
Design Gross Weight-Wheels up	55222	6.89	380699	2.26	124963

Horizontal C.G.

Reference Line = L.E.W. (Root Section)

M.A.C. = 14.7 ft.

L.E. M.A.C. aft reference line = 3.69 ft.

$$C.G. = \frac{6.89 - 3.69}{14.7} = \frac{3.2}{14.7} = 21.8\% \text{ M.A.C.}$$

Vertical C.G.

Below Reference Line = 2.26 ft.

M.A.C. below reference line = 1.58 ft.

C.G. below M.A.C. = .68 ft.

C.G. = 4.6% M.A.C.

*Same as 4-engine tractor

Design Gross Weight-Wheels Down					
Design Gross Weight-Wheels up	55222		380699		124963
Less: Landing Gear-Main-Up	- 3490		- 31992		- 7135
Landing Gear-Nose-Up	- 1460		+ 15146		- 6487
Plus: Landing Gear-Main-Down	+ 3490		+ 34539		+ 24487
Landing Gear-Nose-Down	+ 1460		- 19880		11090
Design Gross Weight-Wheels Down	55222	6.85	378512	2.66	146918

$$\text{Horizontal C.G.} = \frac{6.85 - 3.69}{14.7} = \frac{3.16}{14.7} = 21.5\% \text{ M.A.C.}$$

Vertical C.G. = 2.66 ft. below reference line

Most Forward Flight C.G.					
Design Gross Wt.-Wheels Down	55222		378512		146918
Less: Fuel (2800 gals.)	-16800	7.4	-124320	1.9	- 31920
	38422	6.62	254192	2.99	114998

$$\text{Horizontal C.G.} = \frac{6.62 - 3.69}{14.7} = \frac{2.93}{14.7} = 19.9\% \text{ M.A.C.}$$

Vertical C.G. = 2.99 ft. below reference line

Most Rearward Flight, C.G.					
Design Gross Wt.-Wheels Up	55222		380699		124963
Less: Forward Crew	- 1800		+ 11736		- 7110
Bombs (4-600#)	- 2496	6.5	- 16224	4.5	- 11232
Plus: Most Aft Crew	+ 1800	5.94	+ 10692	3.53	5954
	52726	7.34	386903	2.14	112575

$$\text{Horizontal C.G.} = \frac{7.34 - 3.69}{14.7} = \frac{3.65}{14.7} = 24.8\% \text{ M.A.C.}$$

Vertical C.G. = 2.14 ft. below reference line

BY _____

CHECKED _____